Marks'

Standard Handbook for Mechanical Engineers

Revised by a staff of specialists

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projection-welding processes. It consists of applying the current in a series of impulses, which may be a fraction of a cycle or a number of cycles. The welding machine must be capable of maintaining the pressure while the cyclic operations of current "on" and current "off" are in progress. The advantages of **pulsation welding** are (1) increased electrode life; (2) the welding of thicker material, frequently with the same equipment; (3) better welds in some cases; (4) reduction of "spitting" of weld metal; and (5) the successful spot welding of many thin sections stacked at greater heights. Typical production data for pulsation welding are given in Table 13.3.9.

A continuous resistance-welding process is used in the manufacture of tubular goods. The finished weld resembles a flash weld with a burr of flash ejected at the top and bottom of the weld. Steel strip is fed into the machine and is formed into a circular shape as it passes through several rolls. After the circular shape is secured, two copper rollers, one on each side of the joint, apply the welding current while side rollers apply pressure effecting the weld. Tubing has been produced by this process in low-carbon steels, low-alloy steels, and stainless steels.

In **percussion welding,** the heat for welding is secured simultaneously over the entire area of the abutting surfaces from an arc produced by a rapid discharge of stored electric energy, followed immediately by the application of pressure. The process is used only to a limited extent today.

SURFACING BY WELDING

Surfacing by welding is a method of applying an alloy material to a metal part so as to form a protective surface to resist abrasion, corrosion, heat, impact, or any combination of these factors. Surfacing involves melting the surfacing material (in the form of powder, rod, cord, or wire) and depositing it on the metal part being surfaced. The bond is mechanical, metallurgical, or a combination of the two. In all cases, the surface must be clean. For mechanical bonding, the surface is generally roughened. Metal coatings applied in surfacing operations tend to be porous, brittle, and contain cracks. For these reasons, they are usually applied to areas which will be subject to compressive rather than tensile loads. New parts may be surfaced before use, or worn parts may be built up to the original size and reclaimed. The most important economy derived from surfacing results from prolonged life of parts. Surfaced parts may outwear plain or unfaced ones many times, depending on the type of hard metal used and the service to which they are subjected. To meet the various requirements of hardness, toughness, impact, abrasion-corrosion, heat resistance, and other qualities, numerous surfacing alloys are available. Welding rods and electrodes for this work are covered by Specifications for Surfacing Welding Rods and Electrodes (AWS A5.13). In addition, a commentary is appended to guide the user in the application and expected performance of surfacing filler metals.

BRAZING

Brazing is another one of the general groups of welding processes, consisting of the torch, furnace, induction, dip, resistance, twin carbon arc, flow, and block-brazing processes. Brazing may be used for joining virtually all metals and dissimilar combinations of metals, although not all combinations of dissimilar metals are satisfactory (e.g., aluminum or magnesium to other metals). In brazing, coalescence is produced by heating above 840°F (450°C) but below the melting point of the metals being joined. The nonferrous filler metal used has a melting point below that of the base metal, and the filler metal is distributed in the closely fitted lap or butt joints by capillary attraction. Cleaning of the joints is essential for satisfactory brazing. The use of a flux or atmosphere to control surface cleanliness is usually necessary. Filler metal may be hand-held and fed into the joint (face feeding), or preplaced as rings, washers, shims, slugs, etc.

Brazing with the silver-alloy types of filler metals has previously been known as **silver soldering** and **hard soldering.** Similarly, brazing with **spelter solders** has been known as **spelter brazing.** These terms are now considered obsolete, as the term *brazing* adequately covers joints made by the flow of molten filler metal by capillary attraction. *Braze welding* should not be confused with brazing. Braze welding is a method of welding employing a filler metal which melts below the melting points of the base metals jointed, but the filler metal *is not* distributed in the joint by capillary attraction. (See also Sec. 6.)

Specifications for Brazing Filler Metal (AWS A5.8) provide classifications for various filler metals. The classification numbers use the letter B to signify brazing. Following this letter there appear the chemical symbols representing the principal alloying ingredients. The final numerals differentiate between the several analyses in a group.

Torch brazing uses acetylene, propane, or other fuel gas, burned with oxygen or air. The combination employed is governed by the brazing-temperature range of the filler metal, which is usually above the liquidus. Flux with a melting point appropriate to the brazing-temperature range and the filler metal is essential. Torch brazing may be manual or mechanized.

Furnace brazing employs the heat of a gas-fired, electric, or other type of furnace to raise the parts to brazing temperature. Fluxes may be used, although reducing or inert atmospheres are more common since they eliminate postbraze cleaning necessary with fluxes.

Induction brazing utilizes a high-frequency current to generate the necessary heat in the part by induction. Distortion in the brazed joint can be controlled by current frequency and other factors. Fluxes or gaseous atmospheres must be used in induction brazing.

Dip brazing involves the immersion of the parts in a molten bath. The bath may be either molten brazing filler metal or molten salts, usually brazing flux. The former is limited to small parts such as electrical connections; the latter is capable of handling assemblies weighing several hundred pounds. The particular merit of dip brazing is that the joint is virtually completed all over the assembly at one time.

Resistance brazing utilizes standard resistance-welding machines to supply the heat. Although theoretically any of the filler metals may be used, those of the BAg, BCuP, and BCuZn groups are most common. Either replacement or face feeding of the filler metal may be used. Fluxes or atmospheres must be used, with flux predominating. Standard spot or projection welders may be used. Pressures are lower than those for conventional resistance welding. As currents are large, water cooling of electrodes is essential.

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